APPENDIX F: HOW TO EVALUATE COSTS AND SAVINGS OF ALTERNATIVES

This appendix presents a rudimentary introduction to project financial analysis – whole textbooks have been written on this subject! While you may not quite need that level of detail for assessing your baseline and alternatives, a list of other resources is included in Appendix G (References and Resources). Your accountant can assist you in your analysis as well.

There are many factors to consider when evaluating alternatives. Will the alternatives perform as well? What are the environmental effects of alternatives? How much will each alternative cost? Module 4 describes ways to evaluate alternatives for environmental aspects that you want to change. This Appendix further describes one of those steps – Step 8: Evaluate the cost of the baseline and alternatives – and provides an example and guidance on where in your business to find cost data necessary for this evaluation step.

Many costs, especially environmental costs (waste hauling or disposal costs, for example) are often "hidden" in overhead accounts. These costs are usually unintentionally omitted from a financial analysis. If an alternative will reduce the amount of waste generated, for example, thereby reducing waste disposal costs, this savings may be omitted from a conventional analysis. Other costs and savings may not be included in a financial analysis because they are "less tangible," or difficult to quantify. Table #.1 gives examples of some of these costs. When evaluating alternatives, it is important to fully assess potential costs and benefits of the alternative, as well as your baseline costs, to provide a complete picture of the relative costs and savings.

Table #.1: Examples of Potentially Hidden and Less Tangible Costs

Potentially Hidden Costs	Less Tangible Costs
Up-front: site preparation, permitting, installation	Liability: Superfund, personal injury, property damage
Back-end: site closure, disposal of inventory, post-closure care	Future regulatory compliance costs
Regulatory: training, monitoring, recordkeeping	Employee safety and health compensation
	Organizational image

Evaluating the cost of the baseline and alternatives requires several steps as described below. A description of these steps is followed by an example.

Step 1: Map baseline and alternatives. Module 1 describes how to develop a map of your company's processes, products, and services. This map is important to understanding the activities occurring in your facility that cost you money. To also understand the potential costs and savings of alternatives, it is important to develop process maps for alternatives **if the alternative will vary your current processes.** For example, Figure #.1 shows a metal finisher's baseline cleaning process using a solvent, which is collected and shipped off-site for proper disposal. One alternative examined by the metal finisher was installing a distillation system that could recover 95% of the spent solvent. Figure #.2 shows the process map with the distillation system – spent solvent is collected, recycled on-site, and re-used in the cleaning process. The map helps you

Figure #.1 Current Cleaning Process

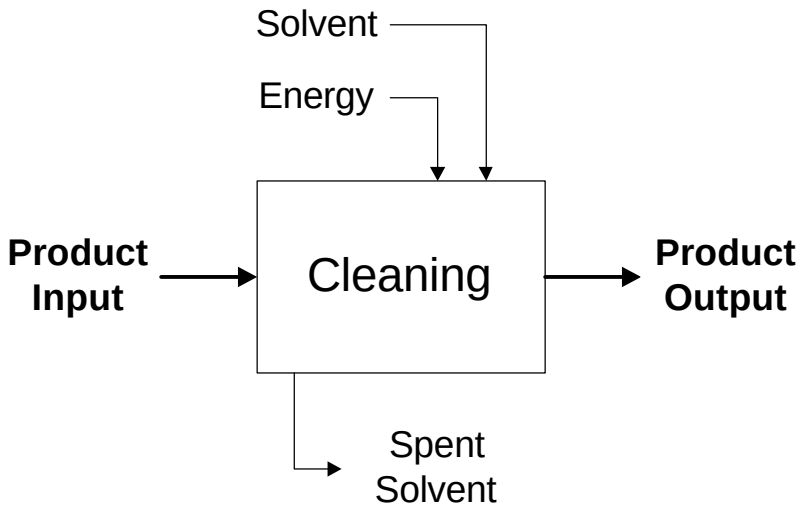
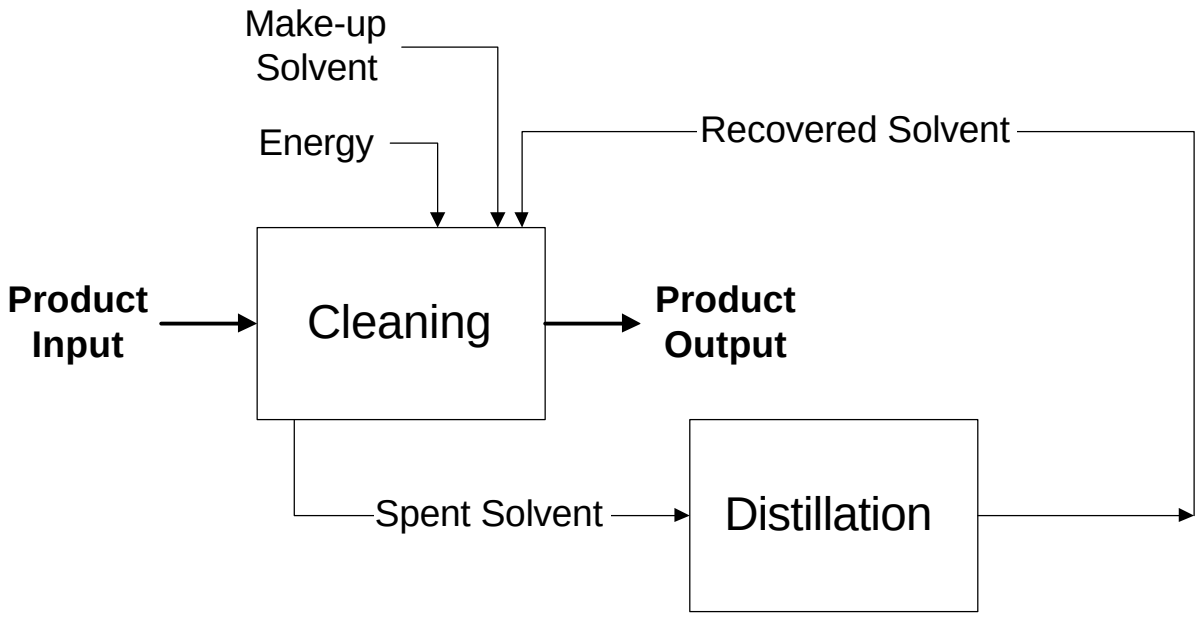


Figure #.2 Alternative Cleaning Process



visualize the differences between the baseline and alternative, and can help guide you in collecting cost data.

Note: Remember to include potentially hidden and less tangible costs.

Step 2: Collect annual operating costs for baseline and alternatives. Using the process maps from Step 1 you can now begin collecting annual operating costs for both your baseline and alternatives. Use Worksheet 4-5a to help you collect cost information. Table #.2 lists examples of some of these costs that may be relevant to your baseline and alternatives. Costs that are the same for the baseline and the alternative can be omitted from the analysis. In the solvent cleaning example, labor time and energy required for cleaning remains the same for both the baseline process and the solvent recycling alternative. Therefore, these costs can be excluded from the analysis.

Be as thorough as possible when considering costs, but don't worry about how you classify costs. For example, you may wish to consider personal protective equipment as a regulatory compliance cost, especially if its use is required by regulations. Alternatively, you may wish to classify all protective equipment as "materials."

Note: Remember that changes in one process may affect costs in other processes. You should include these costs as well.

Environmental projects may save you money not only by reducing your costs, but also by generating revenues. For example, an alternative may increase your product throughput because the activity takes less time to complete, or product quality may be improved enabling you to sell more of your product. The alternative may also let you recover materials previously disposed of, and generate revenues through sales of the reclaimed material (such as recovering metal scrap which can be sold to scrap dealers). These annual revenue effects should be considered using Worksheet 4-5b to assist you. Quantify these revenue effects if possible, and add them to the total operating costs in Worksheet 4-5d. If these potential revenues are difficult to quantify, you can consider them qualitatively in your evaluation by making a note in the last column of Worksheet 4-5d.

By convention, costs (or outflows) are usually denoted by a negative (-) sign while an inflow (or revenue) is denoted by a plus (+) sign. Make sure to keep these signs correct when adding revenues to costs. For example, if the annual operating cost of your alternative is -$20,000, but the alternative will generate an additional $10,000 in revenues, your total annual operating cost would be -$10,000.

Table #.2 Annual Operating Costs

Materials (Purchase, delivery, storage)	**Regulatory compliance (Labor, materials)**
Raw materials	Labeling
Solvents	Manifesting
Catalysts	Recordkeeping
Personal protective equipment	Permitting
Maintenance supplies	Reporting
Direct labor (Wages, benefits)	Protective equipment
Operating	**Insurance**
Supervision	Commercial general liability
Inspection	Workers' compensation
Utilities	Health insurance
Electricity	Pollution liability
Steam	**Future liability**
Water	Fines/penalties
Fuel	Legal costs
Waste management (Labor, materials)	Business shutdown
On-site handling	Personal injury
Treatment	Property/natural resource damage
Storage	Remediation
Hauling	
Disposal	

Step 3: Collect initial investment costs for each alternative. If any of your alternatives will require an investment in new equipment, you will need to consider these costs. These not only include capital costs, but also other one-time costs accompanying your investment**,** such as installation costs or new equipment training. Use Worksheet 4-5c to help you collect these costs. Table #.3 lists examples of these costs that may be relevant to your alternatives.

Step 4: Calculate net present value for the baseline and alternatives. The next step enables you to compare the baseline and alternatives to determine which options appear to be most financially attractive. Because a change in your processes or activities may affect your costs and savings over many years, the analysis should look at long term costs and savings. For example, if you are considering installing new equipment that will last for 10 years, your analysis should include the costs and savings that will accrue to you over the 10 year period. This is especially important for environmental projects which often times reap benefits over the long term.

Table #.3 Initial Investment Costs

Purchased equipment (Purchase, tax, delivery)	**Construction/installation**
Process equipment	Consultant/contractor fees
Storage and materials handling equipment	In-house
Safety/protective equipment	Equipment rental
Monitoring/control equipment	Vendor fees
Laboratory/analytical equipment	**Start-up/training (Labor, materials)**
Waste handling/treatment equipment	Consultant/contractor fees
Initial spare parts	In-house
Utility systems/connection	Safety/environmental training
Electricity	Trials/manufacturing variances
Water	Vendor fees
Steam	**Permitting**
Fuel	Consultant/contractor fees
HVAC	In-house
Plant air	Permit fees
Inert gas	Vendor fees
Sewerage	**Other**
Refrigeration	Buildings
Plumbing	Land
Planning/engineering (Labor, materials)	Contingency
Consultant/contractor fees	Working capital (cash, inventory)
In-house planning/engineering	
Procurement	
Vendor fees	
Site preparation (Labor, materials)	
Consultant/contractor fees	
In-house	
Demolition & clearing	
Equipment rental	
Equipment/rubbish disposal	
Disposal	
Grading/landscaping	
Vendor fees	

A critical component of assessing a project where costs and savings may occur over several years is incorporating the notion that the value of money changes over time – commonly called the "time value of money." Most businesses prefer to have money sooner rather than later. If you have money today, you have the opportunity to use it now to grow your business, for example. Put another way, there is a cost if you receive the money tomorrow instead of today. For example if you receive $1,000 today and put it in the bank receiving 10% interest, at the end of the first year you would have $1,100. This is clearly preferable to receiving $1,000 a year from now. Thus, because $1 today is not equal to $1 tomorrow, you need to adjust the value of future dollars to reflect their diminished value to you today.

The mechanism for making this adjustment is called a discount rate. A discount rate is a percentage that is applied to future costs or revenues to determine its present value. Typically, for business decisions, the discount rate chosen represents the business's cost of capital plus some level of desired return on an investment plus an additional margin to account for uncertainty. Your accountant will be able to assist you in selecting an appropriate discount rate for your analysis.

To calculate the present value (PV) of a cost or savings in the future, use the following equation:

$$PV = \frac{FV_t}{(1+r)^t}$$

where FV = the future value of a cash flow (i.e., a cost or cash outflow, or a revenue or cash inflow) received in year t, and

r = the discount rate.

For example, the present value of a $1,000 revenue you expect to receive over the next four years would be:

$$PV = \frac{\$1000}{(1+0.10)^1} + \frac{\$1000}{(1+0.10)^2} + \frac{\$1000}{(1+0.10)^3} + \frac{\$1000}{(1+0.10)^4} \quad \text{or:}$$

Year	Future Value	Present Value
1	$1000	$ 909
2	$1000	$ 826
3	$1000	$ 751
4	$1000	$ 683
Total		**$3169**

The net present value (NPV) can then be calculated as follows:

$$NPV = \sum PV - I$$

where ΣPV is the sum of the present values of the cash inflow or outflows and
I = the initial investment cost.

In our above example, if the initial investment cost is $1000, then the NPV equals $2169 ($3169 - $1000). If your alternative won't require an initial investment – for example, you are substituting a toxic chemical with a less hazardous chemical, but there are no changes in your equipment, then NPV is equal to the sum of the present values ($3169 in the above example).

Note: In financial analyses, a cost (or outflow) is usually denoted by a negative (-) sign while an inflow (or revenue) is denoted by a plus (+) sign.

NPV can be calculated using a financial calculator, spreadsheet software like Excel, or using project profitability analysis software such as P2/FINANCE (see the resources list at the end of this Appendix).

Step 5: Assess the costs and savings. The last step is to evaluate your baseline and alternatives from a cost and savings perspective. The difference between the alternative and baseline is entered in Worksheet 4-6. A positive number indicates that the alternative saves money, while a negative number indicates that the alternative is more expensive than the baseline. The alternative with the greatest NPV is the most profitable one.

Note: Remember that your accountant can assist you in these calculations.

Example: Baseline vs. Alternative Cleaning Processes

As described above, as part of its EMS, a metal finisher examined methods for reducing solvent use in cleaning. Recovering solvent via a distillation system was one alternative identified. The cost and savings analysis of the baseline versus alternative follows.

Step 1: Map baseline and alternatives. These processes are mapped in Figures #.1 and #.2.

Step 2: Collect annual operating costs for baseline and alternatives. The current annual costs for the baseline are shown in Table #.4. These costs are readily available from purchase orders. Because labor and electricity costs for the cleaning operation remains the same for the baseline and alternative, these costs are omitted from our analysis.

Table #.4 Annual Operating Costs -- Baseline

Annual Operating Costs	$/year
MATERIALS	
Solvent	11,631
WASTE MANAGEMENT	
Solvent disposal	19,041

Annual operating costs for the alternative are shown in Table #.5. Material costs include make-up solvent (because 95% of the solvent is recovered from distillation, make-up solvent must be added) as well as oil and filters for the distillation system. Electricity costs are for operating the distillation system only (electricity use for cleaning is the same for both the baseline and alternative). These costs are available from the equipment vendor.

Table #.5 Annual Operating Costs – Cleaning with Solvent Recovery

Annual Operating Costs	$/year
MATERIALS	
Chemicals	6692
Oil	375
Filters	2284
WASTE MANAGEMENT	
Disposal	439
UTILITIES	
Electricity	241

These operating costs are entered into Worksheet 4-5a. Note that there are no potential annual revenue effects for the alternative project so Worksheet 4-5b is not included.

Step 3: Collect initial investment costs for each alternatives. The initial investment costs for the distillation system, provided by the equipment vendor, appear in Table #.6. These costs are then entered in Worksheet 4-5c.

Table #.6 Initial Investment Costs for the Distillation System

Investment Costs	Cost in $
PURCHASED EQUIPMENT	
Distillation system	26,200
START-UP/TRAINING	
Start-up & Training	750

Worksheet 4-5a – Annual Operating Costs

Alternative	Materials	Direct labor	Utilities	Waste management	Regulatory compliance	Insurance	Future liability	Total Operating Cost
A (Baseline)	11,631		0	19,041				30,672
B	9,351		241	439				10,031

Worksheet 4-5c – Initial Investment Costs

Alternative	Purchased equipment	Utility systems/ connection	Planning/ engineering	Site preparation	Construction/ Installation	Start-up/ training	Permitting	Other	Total Inv. Costs
A (Baseline)	--	--	--	--	--	--	--	--	--
B	26,200					750			26,950

Worksheet 4-5d – Cost Comparison of Alternatives

Alternative	Total Operating Costs (Present Value)	Total Investment Costs (Present Value)	NPV	Annual Revenue Effects (qualitative
A (Baseline)	-233,293	N/A	-233,293	
B	-76,296	-26,950	-49,346	

Worksheet 4-6 – Evaluation of Alternatives

Alternative	Environmental Effects	Performance	Regulatory Considerations	NPV (Alternative – Baseline)	Overall Evaluation
A (Baseline)				--	
B				$183,947	

Step 4: Calculate net present value for the baseline and alternatives. Next, the net present value for the baseline and alternative is calculated using the company's discount rate of 10%. Because the lifetime of the distillation system is 15 years, operating costs are assessed over 15 years. These costs are entered in Worksheet 4-5d. Remember that cash outflows (such as investments or operating costs) are entered using a negative (-) sign while inflows (revenues) are denoted by a plus (+) sign.

Step 5: Assess the costs and savings. Worksheet 4-5d shows that the NPV for the baseline is -$233,293 while the NPV of the alternative is -$49,346. The difference between the alternative and baseline (alternative minus baseline) is entered in Worksheet 4-6. A positive number indicates that the alternative saves money, while a negative number indicates that the alternative is more expensive than the baseline. Worksheet 4-6 shows that the distillation system will save the metal finisher $183,947 over 15 years.

Getting Started – Where to Find Cost Data

You now have the tools to evaluate the cost and savings of your alternatives. However, you may not be sure where to find the data necessary for conducting this analysis. To assist you, Table #.7 lists costs and sources for these data in your business. Note that when collecting similar cost data for your alternatives, suppliers and vendors are frequently a good information source.

Future assessments can benefit from improving your business' current cost tracking system. While at first glance this may seem intimidating, you can begin to incorporate these costs into your accounting framework one step at a time. Begin by tracking a few costs on a routine basis, selecting the most significant costs first. You may want to begin by examining the costs associated with environmental issues to gain a better awareness of how they affect your business' bottom line. Use this awareness to focus your efforts on specific cost areas that appear to have the most importance to your business. As your level of knowledge increases, you can expand your cost tracking system to include other cost data. Eventually you will have a system that meets your needs and provides you with extensive crucial business information.

Table #.7 Where to Find Costs

Cost Category	Data Elements	Where Found	Who to Ask
Process Chemicals	Usage Rates Unit Costs	Production Records Purchase Orders	Foreman Billing Dept.
Ancillary Chemicals	Usage Rates Unit Costs	Prod. Specifications Purchase Orders	Product Engineers Billing Dept.
Storage Space	Total Square Footage Cost/Sq. Ft.	Actual Measurement Rental Contract	Maintenance or Engineering Billing Dept.
Waste Treatment	Flow Rates Total Chemical Costs	WWT Log Sheets Purchase Orders	WWT Operator Purchasing Dept.
Testing	Number of Tests/Year Cost per Test	Environmental Files Invoices	Environmental Manager Accounts Payable
Disposal	Type and Quantity Disposed Unit Costs of Each	Manifests Invoices	Environmental Manager Accounts Payable
Training	Number of People Number of Trainings Length of Training Hourly Labor Rates	Training Records Wage Rate Sheet	Environmental Manager or Contractor Personnel Dept.
Personal Protective Equipment	Type and Quantity Used Cost per Item	Stock Room or Inventory	Environmental Manager Purchasing Dept.
Insurance	Type and Coverage Premium	Capital Budgets Invoices	CFO, Accountant Accounts Payable
Production	Machine Down Time Machine Rates Labor Rates	Prod. Records Operating Budget Personnel Records	Production Manager Finance Dept. Personnel Dept.
Taxes/Fees	Sewer Use Tax Chemical Use Tax Water Use Tax Volume of Weight of Each Taxed Item	Water Bills Environmental Records Water Bills Water, Chemical Usage Records	Accounts Payable Environmental Manager Local POTW Production Manager, Purchasing
Environmental Compliance	Hours of Labor for All Compliance Tasks	Estimates, Salaries, or Environmental Management Records	Environmental Manager
Maintenance Labor	Hours of Labor Tasks Performed	Maintenance Log	Maintenance Dept. Shop Foreman
Maintenance Materials	Amount of Materials Costs of Materials	Maintenance Log Purchase Orders	Maintenance Dept. Purchasing Dept.
Water Usage	Annual Usage Rate Cost/Gal. or Cu. Ft.	Flow Meters or Logs Town Water Bills	Production Manager Accounts Payable
Electricity Usage	Annual Usage Rate Cost/kWh	Equipment Specs. Utility Bills	Production Manager Accounts Payable
Steam Usage	Cost of Production Fraction of Total Used by Process	Fuel Bills, Boiler Maintenance Logs, Count of Processes Using Steam	Accounts Payable Maintenance Dept. Plant Walk-Through
Source: Appendix C of *Total Cost Assessment for Environmental Engineers and Managers* (John Wiley & Sons, 1998).			